Quota Management
In the Commercial Red Snapper Fishery

James R. Waters
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Center for Coastal Fisheries and Habitat Research
101 Pivers Island Road
Beaufort, NC 28516

Running head: Quota Management for Red Snapper

Pre-publication copy
For a published copy, see Waters, James R. 2001. Quota management in the commercial red snapper fishery. *Marine Resource Economics* 16:65-78.

Abstract This paper reviews the economic outcomes of quota management in the commercial fishery for red snapper (*Lutjanus campechanus*) in the Gulf of Mexico. Regulation with a quota on the aggregate catch of red snapper has given fishermen the incentive to fish intensively in each open season to maximize their shares of the overall catch before the quota is reached and the season is closed. The result has been a pattern of shorter seasons, market gluts, depressed prices, and more rules in attempts to alleviate the adverse effects of derby fishing.

Key words: Fishery management, fishing quotas, derby fishing, red snapper.

Introduction

United States fishermen in the Gulf of Mexico have fished commercially for red snapper (*Lutjanus campechanus*) since the 1800s (Camber 1955; Carpenter 1965). A sizeable recreational fishery also exists, but its origin is not documented. Both commercial and recreational fishing pressure has increased over time due to greater demands for commercial fishery products and recreational fishing opportunities and cost-saving technological innovations in fishing equipment and electronics, especially since the end of World War II. Biological investigations have concluded that the red snapper population is overfished (Goodyear 1988; Schirripa and Legault 1999) and regulations have evolved to conserve and rebuild the resource. Since 1990, the principal method of managing the commercial fishery has been with quotas set at 51% of the total allowable catch and seasonal closures after each year's quota was filled [Gulf of Mexico Fishery Management Council (GMFMC) 1989].

The potential adverse economic consequences of quota management are well known. For example, Crutchfield and Zellner (1962) demonstrated that while quota management for the Pacific coast halibut (*Hippoglossus stenolepis*) fishery was considered a success biologically, the economic consequences were less than stellar. As halibut stocks recovered, there were more boats, gear and men than needed to harvest the annual quotas, which resulted in shorter seasons and excessive overall harvesting costs. Fresh fish prices were subject to substantial declines moderated by the diversion of most of the catch to frozen inventories. Fish quality declined and storage costs increased because shorter seasons meant that larger quantities of fish had to be frozen for extended periods.

This paper reviews the economic outcomes of quota management in the commercial red snapper fishery in the Gulf of Mexico. The first closure in 1991 induced a psychology of derby fishing that pervaded the industry once fishery managers demonstrated a willingness and ability to monitor landings and close the fishery when the quota was filled. The result was a pattern of shorter seasons, market gluts, depressed prices, and more rules in attempts to alleviate the adverse effects of derby fishing.

History of Management

The Gulf of Mexico Fishery Management Council regulates the red snapper fishery in Federal waters off Texas, Louisiana, Mississippi, Alabama, and the Gulf coast of Florida through its Fishery Management Plan for the Reef Fish Resources of the Gulf of Mexico. The fishery management plan (FMP) was implemented in November 1984 in response to several problems in the reef fish fisheries, including the harvest of red snapper at smaller than optimal sizes, conflicts among user groups in nearshore waters, and a desire to protect juvenile reef fishes and their habitats (GMFMC 1981). It specified a 12 inch fork length (later restated as 13 inches total length) minimum size limit for red snapper with an allowance to retain up to 5 undersized red snapper, and a prohibition on the use of fish traps, powerheads and roller trawls in designated stressed areas. Patrons on headboats were exempted from the 5 fish possession allowance until May 1987 because of the high incidence of undersized red snapper in catches off the northern coast of Texas.

Amendment 1 to the FMP was implemented in 1990 with additional regulations to extend biological protection to many species in the management unit (GMFMC 1989). With regard to red snapper, it included: a 3.1 million pound commercial quota and a process by which the status of the

stock could be reviewed and the quota adjusted each year; a prohibition on the use of reef fish longlines and buoy gear within 20 fathoms east of Cape San Blas, FL, and within 50 fathoms west of Cape San Blas and off the coasts of other Gulf states to protect large red snapper that were especially vulnerable to these gears; a recreational bag limit of 7 red snapper per person per day; and elimination of the possession allowance for undersized red snapper. Amendment 1 also specified that each boat annually obtain a permit to fish for reef fishes in Federal waters of the Gulf of Mexico. Applicants qualified for permits if more than 50% of their earned income was derived from commercial or charter fishing. A subset of boats with permits was required to submit logbooks to report catch per trip by species until 1993 when all boats with permits were required to submit trip reports.

The quota introduced by Amendment 1 signaled a major change in fishing strategies for commercial fishermen. A 3.1 million pound commercial quota for red snapper did not constrain the fishery in 1990, but a smaller 2.04 million pound quota for 1991 was projected to be reached on August 24 and the fishery was closed for the remainder of the year. The 1991 closure and the expectation of another closure in 1992 sparked a rush for fish, and the commercial red snapper season was closed in late February 1992. The fishery re-opened briefly in April and May of 1992 with a 1000 pound trip limit and then was closed for the remainder of the year. The total catch for 1992 was 3.1 million pounds, well above the 2.04 million pound quota.

Regulations became more numerous in attempts to slow the accelerating rush for fish (Table 1). After the 1992 season, Amendment 4 instituted a moratorium on the issuance of new reef fish

permits in an effort to limit the number of boats in the red snapper fishery (GMFMC 1991).[1] Existing permits could be transferred to another owner when the permitted boat was sold, or transferred to another boat owned by the permit holder. Just prior to the 1993 season, a two-tiered system of trip limits was implemented in which 130 fishermen who documented that they had landed at least 5000 pounds of red snapper in two of the three previous years received an endorsement on their federal permits that entitled them to land up to 2000 pounds of red snapper per trip.[2] Endorsements were not transferable except to another boat owned by the permit holder. Other fishermen with reef fish permits were constrained to a 200 pound trip limit. In a separate adjustment, commercial boats were restricted to landing one trip limit per day. Amendment 5 increased the minimum size limit to 14 inches total length prior to the 1994 season, with further increases to 15 inches scheduled for 1996 and 16 inches for 1998 (GMFMC 1993b), but the final increase to 16 inches was canceled prior to the 1998 season. The commercial quotas were set at 3.06 million pounds for the 1993-1995 seasons, with the seasons to begin in February so that fish would be available during Lent.

National Marine Fisheries Service (NMFS) guidelines specify that an overfished stock be rebuilt within 10 years if feasible, and otherwise within 10 years plus one mean generation time (Restrepo et al. 1998), with mean generation time defined as a weighted average age of spawning individuals in the population. Additional biological work about ageing revealed that red snapper was

[1]The moratorium was extended several times until a license limitation system (GMFMC 1997) was implemented in 1998.

[2]The two-tiered system of trip limits was first implemented by emergency rule in December, 1992, and was formally incorporated into the FMP by Amendment 6 in June, 1993 (GMFMC 1993a).

a longer-lived species than previously thought. Hence the generation time was longer than previously specified (Goodyear 1995). This result allowed the Gulf of Mexico Fishery Management Council to increase the TAC because a more gradual recovery to the same biological goal was possible. The Council could have chosen to maintain the smaller TAC to achieve more quickly the long-term benefits of a fully recovered stock, but fishermen already were lobbying for a larger TAC because catch rates had improved since implementation of quota management.

Commercial quotas were increased to 4.65 million pounds beginning in 1996. A separate fall season was adopted to accommodate the extra landings without exacerbating the market gluts generated by derby fishing during the spring. The spring quotas were set at 3.06 million pounds with the remainder to be allocated to fall seasons that begin each September. Beginning in 1998, Amendment 15 formalized the two-tiered system of trip limits with a license limitation system in which the 130 endorsement holders and 8 historical captains qualified for Class 1 licenses that entitled them to land up to 2000 pounds of red snapper per trip and 559 others qualified for Class 2 licenses to land up to 200 pounds per trip (GMFMC 1997). Licenses could be transferred without restriction. Boats with reef fish permits were constrained to a recreational bag limit of 4 red snapper per person per day if they did not hold a Class 1 or Class 2 license. The spring and fall seasons were operated with an alternating 15-day open and 15-day closed schedule until the quotas were filled in an attempt to prevent the rapid accumulation of landings and depressed prices. The monthly mini-seasons were opened from noon on the first day of each month until noon on the tenth day beginning in the fall of 1999 and spring of 2000.

The Gulf Council proposed that an individual transferable quota (ITQ) program for the commercial red snapper fishery begin in 1996 (GMFMC 1995), but Congressional action in late

1995 prohibited implementation of new management programs based on individual quotas in any U.S. fishery, including the red snapper fishery, before October 2000 (NMFS 1996). Hence, industry-wide quotas followed by closures remains the principal method for managing the commercial red snapper fishery. Other regulations that have been implemented since 1991, such as trip limits, license limitation and mini-seasons, operate within the context of quota management.

Economic Effects of Quota Management

The primary consequence of quota management in the commercial red snapper fishery has been the incentive for individuals to fish early and intensively in each open season to maximize their shares of the overall catch before the quota is reached and the season is closed. Red snapper were caught throughout the year before restrictive quotas were implemented. Now, however, fishing effort has shifted to the regulated open seasons in the spring and fall, and the fishing year is characterized by short periods of intense fishing activity as the threat of imminent closure results in a fishing derby in which the entire year's quota is landed within a few months. Trip logbook reports submitted to the NMFS indicate that, in aggregate, boats often took more than 1000 trips per month during the February and March open seasons (Figure 1). Furthermore, the fishery is intensifying, and open seasons have become shorter despite implementation of trip limits, larger minimum size limits and a limit on the number of licenses issued. Fishermen landed 2.66 million pounds of red snapper without a closure in 1990, 3.25 million pounds in 78 days in 1994, and 4.75 million pounds in only 70 days in 1999 (Table 1).

Shorter seasons have led some to fish in poor weather that normally would be avoided without a derby (Thomas et al. 1993). These fishermen incurred greater risks of breakdowns,

accidents and injuries by fishing in poor weather, and operators of smaller boats (less than 45 feet in length) believe that the need to fish during the short open seasons confers an advantage on larger boats that are better able to fish during adverse weather conditions. Data are not available to test the hypothesis that the intense fishing effort associated with a sustained rush for red snapper eventually leads to fatigue that can reduce productivity and alertness, increases the likelihood of accident or injury, and increases the incidence of boat and gear breakdowns that result in higher repair costs when normal, preventive maintenance is postponed. One advantage of mini-seasons is the likelihood of reducing certain intangible costs of a sustained rush for fish. Scheduled breaks in the open season allow fishermen to rest, spend time with their families, and perform preventive maintenance and minor repairs. On the other hand, the length of mini-seasons has already been reduced from 15 days to 10 days each, which puts more pressure on fishermen to fish in poor weather because the next open period is 20 days away. Thomas et al. (1993) reported that fishermen had less cash to spend for routine maintenance and repair of their boats and equipment immediately after implementation of restrictive quotas. However, data about spending on maintenance and repair have not been available since 1993.

Short periods of intense fishing activity produced market gluts. Monthly catches of red snapper were relatively uniform throughout the year before 1991 (Figure 2). Since then, red snapper landings changed from several hundred thousand pounds per month to nearly two million pounds per month during the spring season of 1997 and more than one million pounds during several mini-seasons. When monthly landings are plotted over time, they appear as spikes of short duration (Figure 2).

Predictably, market gluts are associated with markedly lower dockside prices. Red snapper prices have declined sharply at the beginning of each open season because dockside buyers cannot easily market the entire year's catch during the relatively short seasons associated with derby fishing. When average monthly prices are plotted over time, they exhibit sharp dips that correspond to the large quantities landed during open seasons (Figure 2).[3] Thus, average monthly prices have exhibited greater variance in response to the extreme fluctuations in landings. Prices were relatively stable prior to implementation of restrictive quotas as landings occurred throughout the year.

Long-term trends in dockside prices are illustrated better with average annual prices, calculated as annual dockside revenues for red snapper divided by annual landings expressed on a live weight basis. Average annual red snapper prices generally rose over time both in nominal and real terms prior to the first closure in 1991, and were consistently higher than prices for other reef fishes (Figure 3). Since then, nominal prices have declined to their lowest levels since the mid-1980s while real prices have declined to their lowest levels since the early 1970s. Although red snapper historically brought the highest prices among reef fishes, average annual prices for groupers have exceeded prices for red snapper since 1992 because of the effects of derby fishing on red snapper prices.

The relationship between real average annual prices and annual landings reveals distinct groupings of data which correspond to the periods prior to and after implementation of restrictive

[3]Data files about commercial landings and dockside value from 1962-present are maintained by the National Marine Fisheries Service, Southeast Fisheries Science Center, Office of Fisheries Statistics, 75 Virginia Beach Drive, Miami, FL 33149. Average monthly prices were calculated as the ratio of monthly revenues and quantities landed as reported in NMFS general canvas and logbook data files. By this method, prices existed in nearly all months of the year because small quantities were reported to have been landed, presumably from state waters, even during closed red snapper seasons.

quotas and seasonal closures (Figure 4). Observations exhibited a negative slope prior to quota management because landings declined while prices rose throughout much of the 1962-1990 period. Observations associated with restrictive quotas and closures during the 1992-1999 period also displayed a negative slope, but along a line closer to the origin. For any given quantity, dockside prices for red snapper were lower when the fishery was managed with restrictive quotas. The observation for 1991 reflects a transition between year-round fishing activity without restrictive quotas and the fishing derbies associated with restrictive quotas and closures. Landings were about average during the first few months of 1991, but the fishery began to accelerate its rate of harvest in the late spring and early summer when it became apparent that the NMFS planned to close the fishery when the quota was reached.

The magnitude of the vertical difference shown in Figure 4 for dockside prices between the 1962-1990 period prior to quota management and the 1992-1999 period after implementation of restrictive quotas and seasonal closures was estimated with a single equation linear model in which real average annual dockside prices, $P_{rs,t}$, for red snapper landed at U.S. ports in the Gulf of Mexico were expressed as a function of total gulf-wide landings of red snapper, $Q_{rs,t}$, binary intercept shifters, $D_{91,t}$ and $D_{9299,t}$, that separate the 1991 transition year and the 1992-1999 period of restrictive quotas from the 1962-1990 period before implementation of quota management, the quantities of snappers (all species combined) imported, $M_{s,t}$, real total disposable income, Y_t, and real average annual dockside prices for groupers, $P_{g,t}$, as an alternative for consumers of red snapper.[4]

[4]Groupers represent consumption alternatives offered by the restaurant industry, although not necessarily in the same restaurants at exactly the same time. The opportunity for red snapper fishermen to harvest groupers as an alternative fishing activity is limited because most groupers are caught primarily in the eastern Gulf of Mexico rather than in the northern Gulf with red snapper.

$$P_{rs,t} = 1.1661 - 0.5131\ D_{91,t} - 1.1391\ D_{9299,t} - 0.0516\ Q_{rs,t} - 0.0248\ M_{s,t} + 0.2877\ Y_t + 0.4522\ P_{g,t}$$

$$(0.4678)\ (0.1267) \qquad (0.1299) \qquad (0.0207) \qquad (0.0078) \qquad (0.1024) \quad (0.1010)$$

Standard errors for the estimated coefficients are presented in parentheses. The regression used annual data for 1962-1987 and 1991-1999 (n=35) and had a high level of overall significance (R^2=0.94).[5] Landings and imports were expressed as millions of pounds on a live weight basis. Prices were expressed as dollars per pound, live weight, in real terms with 1999 as the base year. Real disposable income was expressed as trillions of dollars. By definition, $D_{91,t}$ = 1 for 1991 and 0 otherwise and $D_{9299,t}$ = 1 for 1992-1999 and 0 otherwise.

Implementation of restrictive quotas and their resulting fishing derbies was associated with a downward shift in the estimated price-quantity relationship and a decline in industry-wide dockside revenues for red snapper fishermen. For any given quota, dockside prices for red snapper were estimated to be about $1.14 per pound lower in real terms when the fishery was managed with restrictive quotas as prices fell due to the difficulties of marketing an entire year's catch within a short period of time. Commercial fishermen landed 31.8 million pounds of red snapper between 1992 and 1999 worth $65.7 million in 1999 dollars. If the estimated value of $D_{9299,t}$ = $1.14 per pound adequately describes ex-vessel price response to quota management, then commercial fishermen might have earned an additional $36.3 million from 1992-1999, or about 55% more in real terms than they actually earned with derby fishing, assuming that other factors would have remained unchanged. Nevertheless, red snapper continues to be the top revenue-generating reef fish in the

[5]The reported equation corrects for a first-order autoregressive error structure following *SAS proc autoreg,* with a corrected D-W=1.68. The time series included 1988-1990 as missing values because data for imports were not available.

northern Gulf of Mexico, despite its overfished status and the effects of quota management on dockside prices.

Another consequence of quota management for the red snapper fishery has been a transfer of fishing effort to other species when the red snapper fishery is closed (Thomas et al. 1993). Vermilion snapper (*Rhomboplites aurorubens*) is the primary alternative species, with boats fishing for vermilions throughout the closed season for red snapper. Unfortunately, switching behavior has increased fishing mortality on substitute species at a time when biologists believe that many reef fishes in the Gulf of Mexico are already in an overfished condition or are approaching an overfished condition (NMFS 1999).[6] In addition, the production of fishing effort for other reef fishes yields incidental catches of red snapper which must be discarded or released, although the magnitude of the problem and the survival rate for commercially released fish have not been studied adequately.

In principle, consumers benefit from the market gluts associated with derby fishing because large supplies of red snapper are available for consumption at low prices, at least during the open seasons. Nevertheless, the Gulf red snapper fishery is closed for the majority of the year when consumers must rely on alternative sources of supply. Red snapper also are caught along the Atlantic coast, but they are not abundant and the fishery has averaged less than 150 thousand pounds of red snapper per year since 1991. Imports of fresh/chilled snappers constitute the primary alternative source of supply. There are no data about frozen inventories, which are minimal. Red snapper

[6] Although the vermilion snapper stock is beginning to show signs of decline (Schirripa 1998), the commercial fishery is not regulated except for the requirement that participating boats have federal reef fish permits. Commercial red snapper fishermen also could fish for several lesser valued species such as king mackerel (*Scomberomorus cavalla*), which is regulated with a quota and closures. King mackerel are migratory and available seasonally. Hence, king mackerel is not a mainstay type fishery like red snapper, and fishermen fished for them during short seasons even before quotas were implemented.

usually are eviscerated, packed in ice and marketed in fresh, whole form. Fish quality remains high because trips are shorter and fish are well-iced since there is extra hold space now that landings are limited to 2000 pounds or less.

Disruptions in the supply of domestically caught red snapper during closed seasons have contributed to the transformation of the U.S. market for red snapper from one that was supplied by the domestic fishery and supplemented with imports to one that is supplied by imports and supplemented with domestically caught fish during the open seasons. Compilations of unofficial data from U.S. Customs offices suggest that imports of snappers through southeastern ports usually averaged less than one million pounds annually prior to 1972 (Cato and Prochaska 1976) when domestic landings usually exceeded 10 million pounds. Imports of snappers (all Lutjanid species combined) through southeastern ports increased from less than 5 million pounds in 1983 to about 14 million pounds in 1987 (Adams and Lawlor 1989) when domestic landings fell from about 7 million pounds to less than 4 million pounds. Data are unavailable between 1988 and July 1990 when official reporting of snapper imports began. The quantities imported of fresh and frozen Lutjanids more than doubled between 1991 and 1997, from 12.4 to a record 26.5 million pounds, and declined slightly to 25.5 million pounds in 1999 (Figure 5).[7] While imports probably would have increased even in the absence of a decline in the domestic fishery due to the devaluation of the Mexican peso in the mid-1990s, the short open seasons may have hastened the expansion of the

[7]In 1999, the U.S. imported 22.8 million pounds of fresh, chilled snappers in whole form, and 2.7 million pounds of frozen snappers in whole form. Data are not available about imports that were processed beyond evisceration. For example, fillets are included in a general category and cannot be identified by species group. Data from July 1990-present are maintained by the National Marine Fisheries Service, Office of Science and Technology, Fisheries Statistics and Economics Division, 1315 East-West Highway, Silver Spring, MD 20910.

import market to satisfy consumer demand during the closed seasons. Mexico is the primary source of imported snappers.

Summary and Discussion

The current method of managing the commercial red snapper fishery with annual quotas has created a fishing derby in which fishermen fish as quickly as possible before the quota is filled and the season is closed because those who wait may end up with smaller shares of the overall quota. The result has been large quantities of fish being harvested and sold in a short time interval, with markedly lower prices. Although this outcome was expected in a general sense, the speed and magnitude of its occurrence offers lessons and reminders for economists, biologists and fishery managers who should hope to avoid a repetition of the red snapper experience as they contemplate management of the grouper fishery along the west coast of Florida.

The predicted outcomes of quota management for red snapper occurred rapidly and decisively. The first closure occurred in August 1991 and a full-scale race for fish ensued as soon as the fishery re-opened in February 1992. The red snapper experience demonstrates that significantly shorter seasons, market gluts and depressed market prices can occur almost immediately and without investment in additional fishing power such as bigger boats, newer fishing gear and better electronics.

Quota management can lead to a host of regulatory adjustments intended to slow the rate of harvest and support higher dockside prices. The types of adjustments employed for the commercial red snapper fishery include: increases in the minimum size limit; minimum income requirements to qualify for a commercial permit; quotas followed by closures; a limit on catch per trip; a moratorium

on issuance of new permits; an endorsement system with two classes of trip limits; a license limitation system with two classes of licenses and associated trip limits; a limit of one landing per boat per day; allocation of quota into spring and fall seasons; splitting seasons into a series of mini-derbies of 15 days each; and a reduction in the length of mini-derbies.[8] Throughout, biologists were inundated with lengthy lists of possible management alternatives and adjustments to evaluate.

These adjustments are all manifestations of quota management designed to mitigate its adverse consequences. Regulatory adjustments may slow the overall rate of harvest by commercial fishermen, but only temporarily because they do not alter the basic incentive to fish as intensively as possible when the fishery is open. Fishermen who wait still risk losing the opportunity to harvest larger shares of the overall quota.

The regulatory choices that confront fishery managers will become more difficult and contentious over time. Stock recovery is expected to proceed slowly at first and then accelerate as the numbers of fish in older cohorts increases. Biological improvements will make fish easier to catch as the red snapper population recovers over time. Fishery managers will want to maintain their long-term rebuilding schedule for red snapper, but the need to limit catches will become less apparent to fishermen as they experience improvements in their catch rates. Additional enforcement may be needed over time because the incentives to land red snapper illegally during the open and closed seasons will increase as catch rates, and hence the profitability of fishing, increase. The result

[8]Management of the recreational fishery also has become more restrictive with increases in the minimum size limit, a limit on daily catch per person per day, and reductions in the allowable catch per person per day. However, allocations for the recreational sector, defined as 49% of total allowable catch, were not enforced and routinely exceeded before 1997. Closures of the recreational fishery first occurred in 1997, and open seasons have gotten successively shorter each year.

is expected to be continually shorter fishing seasons and the need for more complex rules in the future.

ITQs represent an alternative to quota management in which the pressure for everyone to fish early in the season should not exist because the timing of the harvest of each individual's share of the overall quota is independent of the fishing decisions made by competing fishermen (Moloney and Pearse 1979). Hence, some fishermen likely would postpone part of their catches to take advantage of higher prices later in the season, thereby helping to eliminate the market gluts that reduce fish prices. Fishing may occur throughout the year, with peak production occurring during times of high demand, seasonally high catch rates, or favorable weather conditions. In this respect, the seasonal pattern of fishing with ITQs for red snapper might be similar to that of the less intense, paced production that existed prior to quota management, and the relationship between price and landings might revert to that exhibited prior to 1991. Commercial quotas for red snapper have been set at 4.65 million pounds annually since 1996. At $1.14 per pound in real terms and other factors constant, commercial fishermen might have earned an additional $5.3 million per year in 1999 dollars with ITQs rather than quotas. The prohibition on the development of new ITQ programs in U.S. fisheries has prolonged the system of quota management with its fishing derbies and depressed prices for red snapper, but given resistence to the principle of property rights in fisheries (Huppert 1989; Knapp 1997), it also has created additional time to investigate the advantages and disadvantages of ITQs (e.g., National Research Council 1999).

Acknowledgements

The comments and suggestions by Bill Antozzi, Mike Travis, Walter Keithly and three anonymous journal referees are gratefully appreciated.

References

Adams, C.M., and F.J. Lawlor, III. 1989. Trends in the importation of selected fresh and frozen seafood products into the southeastern United States. Florida Sea Grant Technical Paper TP-59, Florida Sea Grant, Gainesville.

Camber, C.I. 1955. A survey of the red snapper fishery of the Gulf of Mexico, with special reference to the Campeche Banks. Florida Board of Conservation, Technical Series Number 12, University of Miami, Coral Gables.

Carpenter, J.S. 1965. A review of the Gulf of Mexico red snapper fishery. U.S. Department of Interior, Fish and Wildlife Service, Bureau of Commercial Fisheries, Circular 208, Washington, D.C.: U.S. Government Printing Office.

Cato, J.C., and F.J. Prochaska. 1976. The Gulf of Mexico commercial and recreational red snapper-grouper fishery: An economic analysis of production, marketing, and prices. In H.R. Bullis, Jr., and A.C. Jones, eds., pp. 95-128. Proceedings: Colloquium on snapper-grouper fishery resources of the western central Atlantic Ocean. Florida Sea Grant Report Number 17, Florida Sea Grant, Gainesville.

Crutchfield, J., and A. Zellner. 1962. Economic aspects of the Pacific halibut fishery. *Fishery Industrial Research* 1:1-73. Washington, D.C.: U.S. Government Printing Office.

Goodyear, C.P. 1988. Recent trends in the red snapper fishery of the Gulf of Mexico. Contribution CRD 87/88-16, Southeast Fisheries Center, Miami Laboratory, Coastal Resources Division, 75 Virginia Beach Drive, Miami, FL 33149.

Goodyear, C. P. 1995. Red snapper in U.S. waters of the Gulf of Mexico. Contribution MIA 95/96-05, Southeast Fisheries Science Center, Miami Laboratory, Coastal Resources Division, 75 Virginia Beach Drive, Miami, FL 33149.

Gulf of Mexico Fishery Management Council. 1981. Environmental Impact Statement and Fishery Management Plan for Reef Fish Resources of the Gulf of Mexico. Lincoln Center, Suite 881, 5401 West Kennedy Boulevard, Tampa, FL 33609.

Gulf of Mexico Fishery Management Council. 1989. Amendment Number 1 to the Reef Fish Fishery Management Plan. Lincoln Center, Suite 881, 5401 West Kennedy Boulevard, Tampa, FL 33609.

Gulf of Mexico Fishery Management Council. 1991. Amendment 4 to the Reef Fish Fishery Management Plan for the Reef Fish Resources of the Gulf of Mexico. Lincoln Center, Suite 881, 5401 West Kennedy Boulevard, Tampa, FL 33609.

Gulf of Mexico Fishery Management Council. 1993a. Amendment 6 to the Reef Fish Fishery Management Plan for the Reef Fish Resources of the Gulf of Mexico. Lincoln Center, Suite 881, 5401 West Kennedy Boulevard, Tampa, FL 33609.

Gulf of Mexico Fishery Management Council. 1993b. Amendment 5 to the Reef Fish Fishery Management Plan for the Reef Fish Resources of the Gulf of Mexico. Lincoln Center, Suite 881, 5401 West Kennedy Boulevard, Tampa, FL 33609.

Gulf of Mexico Fishery Management Council. 1995. Amendment 8 and Environmental Assessment (Effort Management Amendment) to the Reef Fish Fishery Management Plan for the Reef Fish Resources of the Gulf of Mexico. Lincoln Center, Suite 881, 5401 West Kennedy Boulevard, Tampa, FL 33609.

Gulf of Mexico Fishery Management Council. 1997. Amendment 15 to the Fishery Management Plan for the Reef Fish Fishery of the Gulf of Mexico. 3018 U.S. Highway 301 North, Suite 1000, Tampa, FL 33619.

Huppert, D. D. 1989. Comments: Is fishery management at a turning point? Reflections on the evolution of rights based fishing. *Rights Based Fishing*, P. A. Neher, R. Arnason, and N. Mollett, eds., pp. 65-68. Boston: Kluwer Academic Publishers.

Knapp, G. 1997. Initial effects of the Alaska halibut IFQ program: Survey comments of Alaska fishermen. *Marine Resource Economics* 12:239-248.

Moloney, D.G., and P.H. Pearse. 1979. Quantitative rights as an instrument for regulating commercial fisheries. *Journal of the Fisheries Research Board of Canada* 36:859-866.

National Marine Fisheries Service. 1996. Magnuson-Stevens fishery conservation and management act: As amended through October 11, 1996. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-F/SPO-23, Washington, D.C.: U.S. Government Printing Office.

National Marine Fisheries Service. 1999. Our living oceans: Report on the status of U.S. living marine resources, 1999. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-F/SPO-41, Washington, D.C.: U.S. Government Printing Office.

National Research Council. 1999. *Sharing the Fish: Toward a Policy on Individual Fishing Quotas*. Washington, D.C.: National Academy Press.

Restrepo, V.R., G.G. Thompson, P.M. Mace, W.L. Gabriel, L.L. Low, A.D. MacCall, R.D. Methot, J.E. Powers, B.L. Taylor, P.R. Wade, and J.F. Witzig. 1998. Technical guidelines on the use of precautionary approaches to implementing national standard 1 of the Magnuson-

Stevens Fishery Conservation and Management Act. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-F/SPO-31, Washington, D.C.: U.S. Government Printing Office.

Schirripa, Michael J. 1998. Status of the vermilion snapper fishery of the Gulf of Mexico: Assessment 4.0 (revised). Sustainable Fisheries Division Contribution SFD-97/98-09A, Southeast Fisheries Science Center, Sustainable Fisheries Division, 75 Virginia Beach Drive, Miami, FL 33149-1099.

Schirripa, M.J., and C.M. Legault. 1999. Status of the red snapper in U.S. waters of the Gulf of Mexico: Updated through 1998. Sustainable Fisheries Division Contribution SFD-99/00-75, Southeast Fisheries Science Center, Sustainable Fisheries Division, 75 Virginia Beach Drive, Miami, FL 33149-1099.

Thomas, J.S., G.D. Johnson, C.M. Formichella, and C. Riordan. 1993. Perceived social and economic effects of current management policies on red snapper fishermen operating in the Gulf of Mexico: A report to the Gulf of Mexico Fishery Management Council. Unpublished report, University of South Alabama.

TABLE 1. DURATION OF FISHING SEASONS FOR THE COMMERCIAL RED SNAPPER FISHERY IN THE GULF OF MEXICO

YEAR	QUOTA (Million Pounds)	SEASON OPEN (Dates)	DAYS OPEN	ACTUAL CATCH (Million Pounds)	REMARKS
1990	3.10	Jan 1-Dec 31	365	2.66	12 inch (fork length) minimum size limit. Bottom longlines prohibited within 50 fathoms west of Cape San Blas, FL, and within 20 fathoms elsewhere.
1991	2.04	Jan 1-Aug 24	236	2.24	First year that commercial red snapper fishery was closed.
1992	2.04	Jan 1-Feb 22, Apr 4-May 15	95	3.04	Season re-opened April 4-May 15 with 1000 pound trip limit.
1993	3.06	Feb 16-May 20	95	3.41	First year of two-tiered system of trip limits; 2000 lbs for boats with endorsements and 200 lbs for other boats with reef fish permits.
1994	3.06	Feb 10-Apr 27	78	3.25	Minimum size limit increased to 14 inches, total length; Two-tiered system of trip limits.
1995	3.06	Feb 24-Apr 14, Nov 1-Nov 2	51	3.08	Season re-opened for 36 hours Nov 1-2; Two-tiered system of trip limits.
1996	4.65	Feb 1-Apr 4, Sep 15-Oct 7	77	4.47	First year of planned spring (3.06 million pounds) and fall (for the remaining unfilled quota) seasons; Minimum size limit increased to 15 inches, total length; Two-tiered system of trip limits.
1997	4.65	Feb 1-Mar 25, Sep 2-Sep 15,	74	4.87	Two-tiered system of trip limits; The fall season opened for the first 15 days of each month or until the quota was filled.

		Oct 1-Oct 6			
1998	4.65	Feb 1-Feb 15,	72	4.97	First year of license limitation system with trip limits of 2000 lbs for Class 1 boats
		Mar 1-Mar 15,			and 200 lbs for Class 2 boats;
		Apr 1-Apr 12,			The spring season opened during the first 15 days of each month or until 3.06 million
		Sep 1-Sep 15,			pounds had been caught.
		Oct 1-Oct 15			The fall season was opened for the first 15 days of each month or until the quota was filled.
1999	4.65	Feb 1-Feb 15,	70	4.75	License limitation for Class 1 and Class 2 boats.
		Mar 1-Mar 15,			The spring season opened during the first 15 days of each month or until 3.06 million
		Apr 1-Apr 15,			pounds had been caught.
		Sep 1-Sep 10,			The fall season opened during the first 10 days of each month or until the quota was filled.
		Oct 1-Oct 10,			
		Nov 1-Nov 5			
2000	4.65	Feb 1-Feb 10,	76	4.88	License limitation for Class 1 and Class 2 boats.
		Mar 1-Mar 10,			The spring season opened during the first 10 days of each month or until 3.06 million
		Apr 1-Apr 10,			pounds had been caught.
		May 1-May 8,			The fall season opened during the first 10 days of each month or until the quota was filled.
		Sep 1-Sep 10,			
		Oct 1-Oct 10,			
		Nov 1-Nov 10			
		Dec 1-Dec 8			

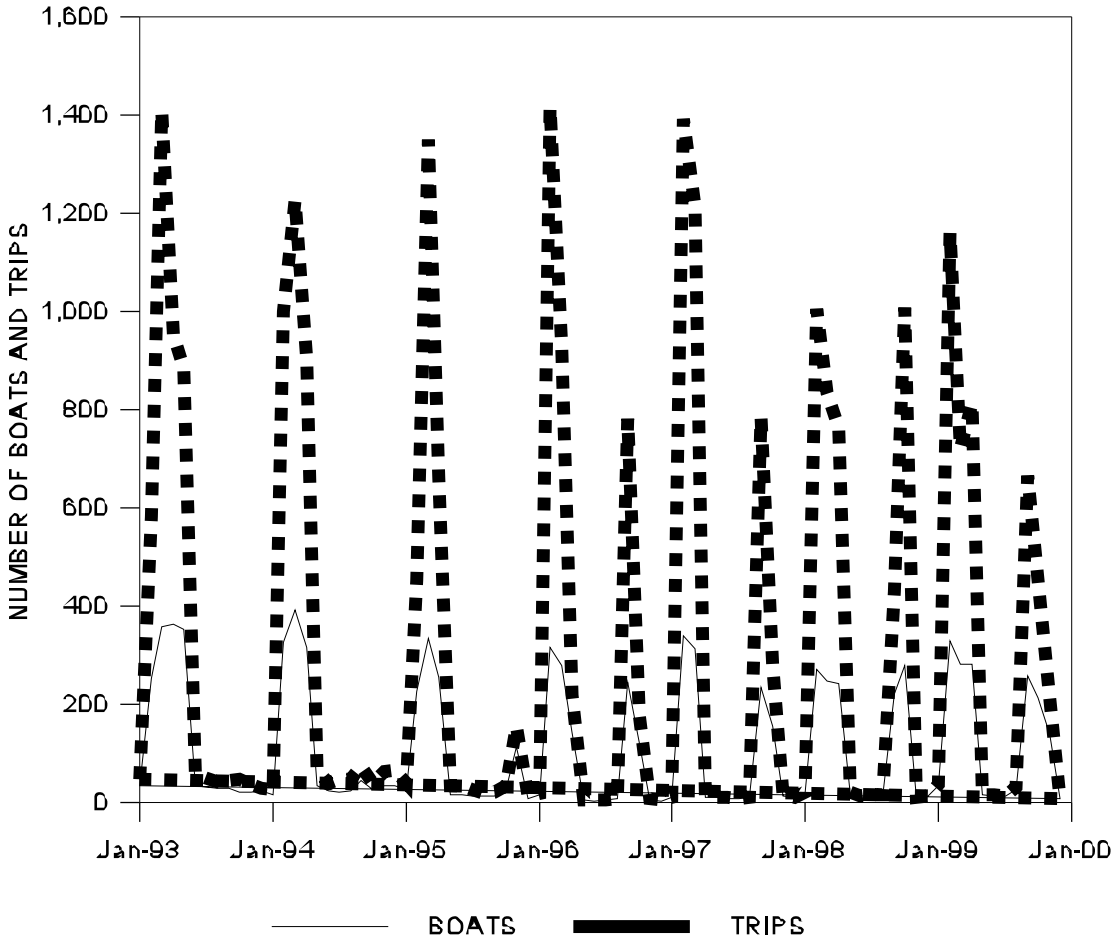

Fig. 1. Number of boats and trips that reported having landed red snapper in the Gulf of Mexico, by month, 1993-1999. Measures of industry-wide fishing effort prior to 1993 are not available.

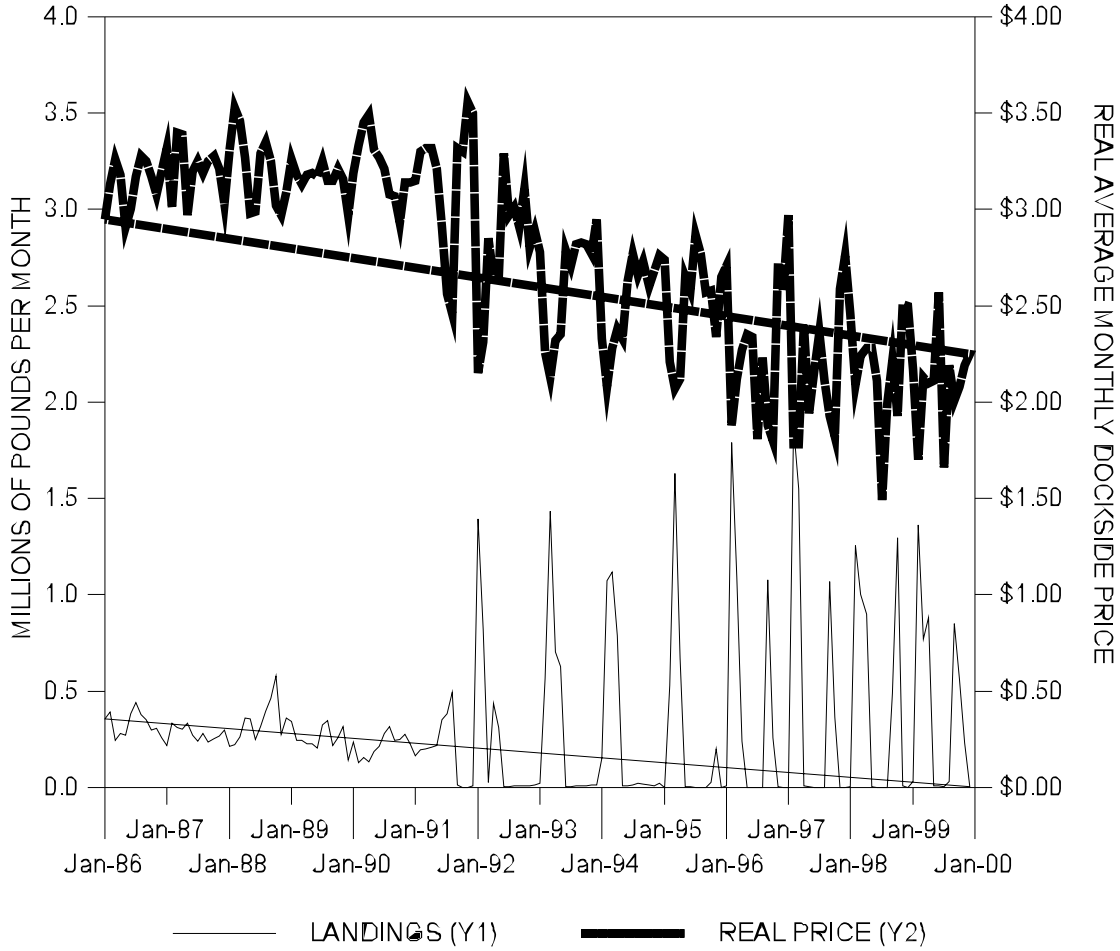

Fig. 2. Monthly landings (live weight) and real average monthly dockside prices per pound (live weight) for red snapper in the Gulf of Mexico, 1986-1999. Real prices were calculated as current price divided by the CPI-U with 1999 as the base year.

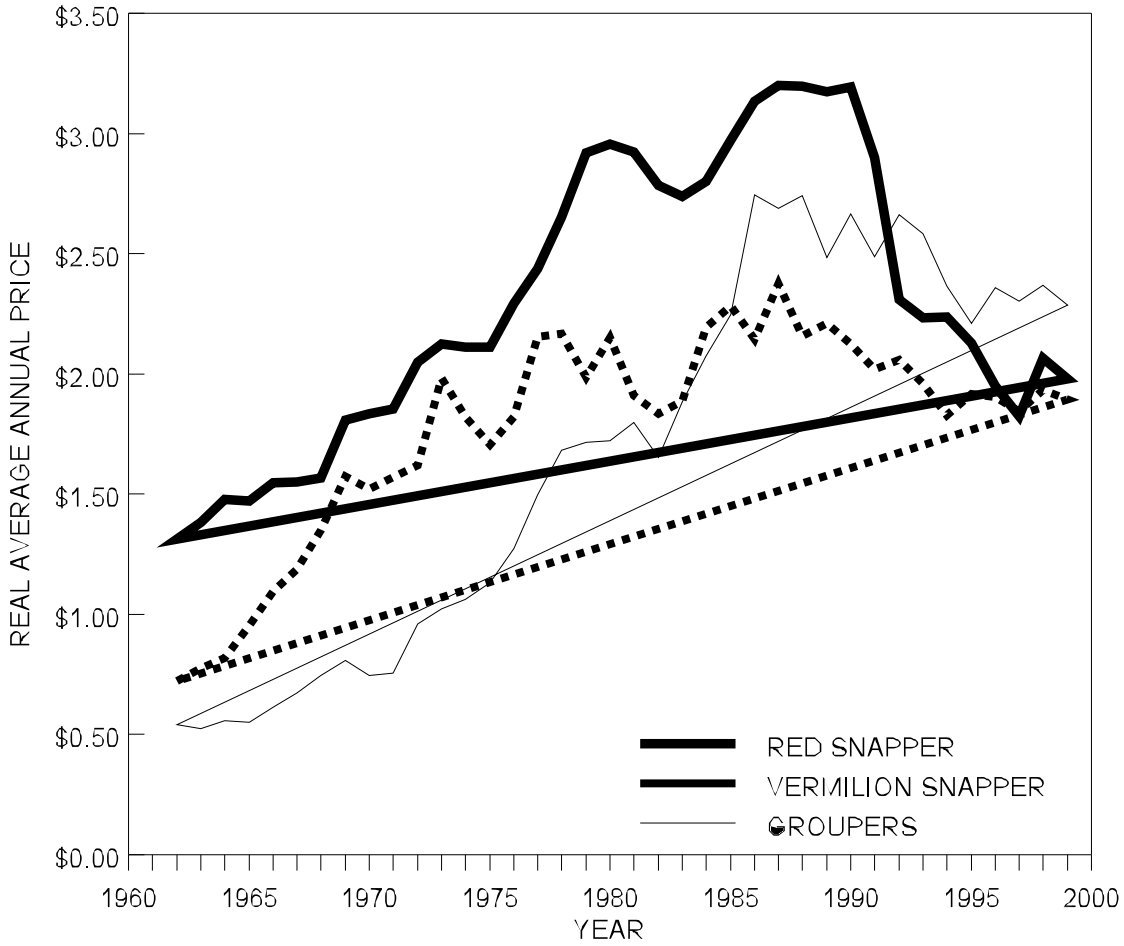

Fig. 3. Real average annual dockside prices (with a 1999 base year) for reef fishes landed in the Gulf of Mexico, 1962-1999.

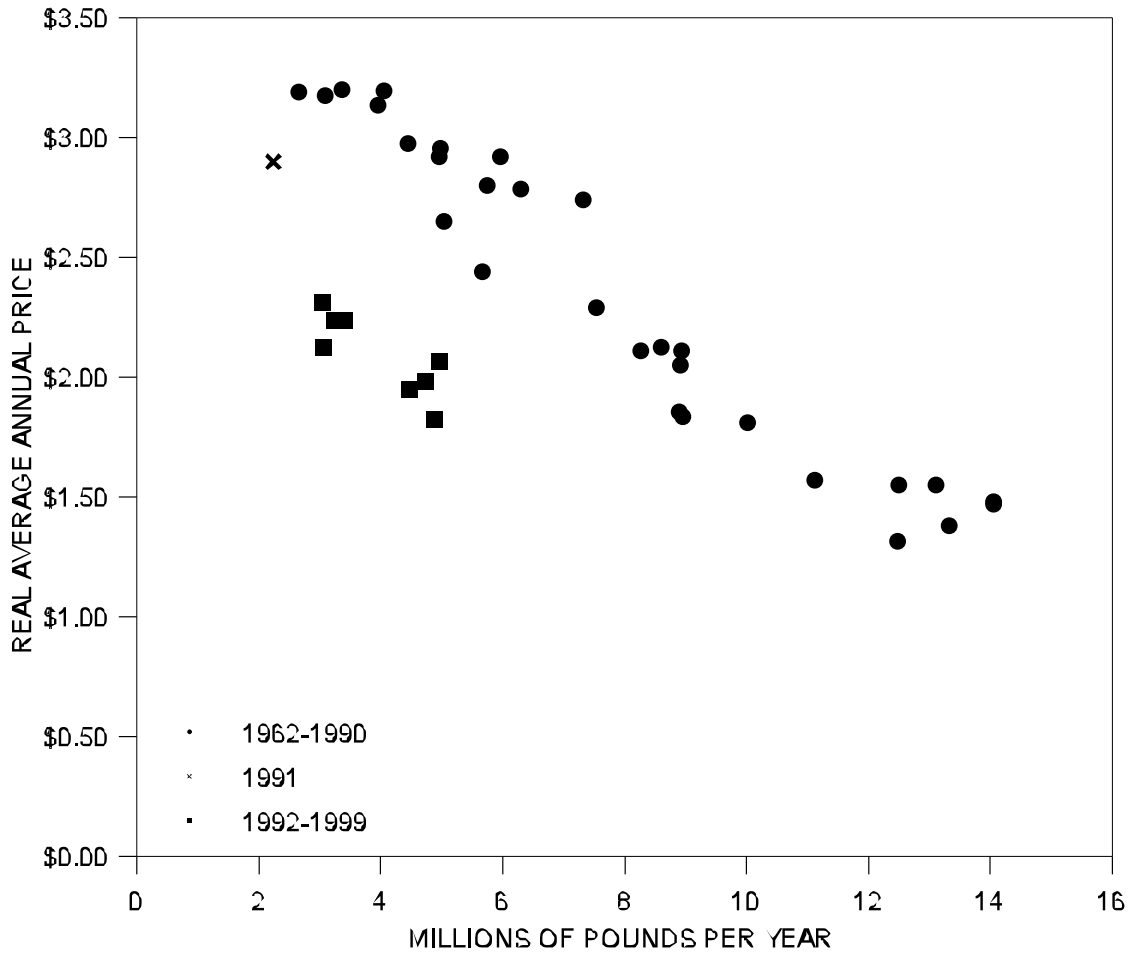

Fig. 4. Real average annual dockside prices for red snapper (with a 1999 base year) plotted against millions of pounds landed (live weight) per year, 1962-1999.

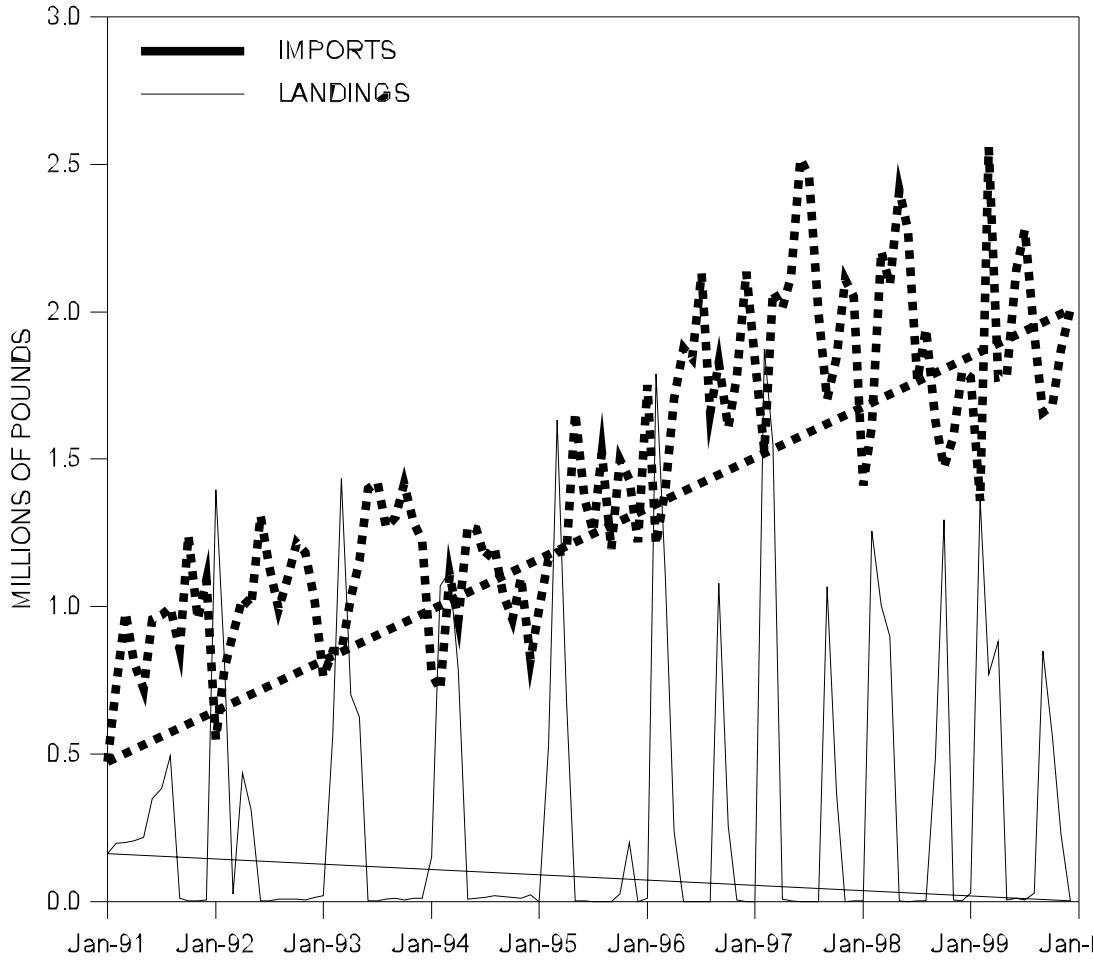

Fig. 5. Monthly imports of all snapper species combined and monthly landings of red snapper in the Gulf of Mexico, 1991-1999.